



New Structure of the Muscles and Heart

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THOMÆ BARTHOLINI  
ÉPISTOLARUM  
MEDICINALIUM  
CENTURIA IV.

Variis Observationibus  
curiosis & utilibus re-  
ferta.



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HAFNIÆ,  
*Typis MATTHIÆ GODICCHENII.*  
Sumptibus PETRI HAUBOLD, Acad. Bibl.  
ANNO CL IX c LXVI

HUNDRED  
MEDICAL LETTERS  
OF THOMAS BARTHOLIN  
CONCERNING DIFFERENT STRANGE  
AND USEFUL OBSERVATIONS

FOURTH EDITION

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COPENHAGEN

*Published by MATTHIAS GODICCHEN*  
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Translated by P. Maquet, M.D., and Sister M. Emmanuel Collins, O.S.F., Ph.D.

## EPIST. LXX.

*Nova Musculorum & Cordis fabrica.*

THOMAS BARTHOLINI Hafniam.

**A**Pologiz Prodomum Nicolao Kragie transmisi Tibi offerendum, spero rit curatum. A Clarissimo Sylvio disputationum de novo impressorum, aliarumq; de febribus exemplaria quædam accepi amicis offerenda. quos inter cum nemo mihi sit, quam Tu Celsus berrime Vir, majori veneratione colendus hisce diebus Hafniam petenti amico tradidisti exhibenda. Cetera, in cordis & musculorum versor scrutinio, sperans brevi, si sufficiens isti labori otium facta permiserint, me utriusq; fabricam cum figuris absoluturum. In musculis quæ observavi, an ab aliis fuerint notata, Tua me infinita docebit lectio. Facebo vasorum, quæ necdum nisi pauca, eaq; non magni adeo momenti exhibuerunt, quod vero fibras eorundem spectat, elegantem earum mirari satis nequeo structuram. Quamlibet solam considerans fibram carnosam in medio, in ultraq; extremitate videbit nervosam, id quod & satis vulgare, sed omnium junctorum compositione mihi visa rarius. Carnosa namq; portione non ab uno musculi extremo versus alterum recte

NEW STRUCTURE  
of the  
MUSCLES AND HEART

To Thomas Bartholin in Copenhagen

I sent to Niels Krag the *Prologue* of the APOLOGIA to be presented to you. I hope this was taken care of properly. I received some copies of the debates published again by the famous *Sylvius* and of other publications on fevers, to be offered to friends. Among these friends there is none who deserves more my veneration than you, illustrious Sir. I trusted the documents to a friend who goes to Copenhagen these days to deliver them to you. For the rest, I am busy with a thorough examination of the heart and muscles, hoping, if the events leave me enough time for this work, to complete soon the structure of both with figures. Whether that which I observed in the muscles was noted by others, your boundless reading will teach me. I will not mention the vessels which did not yet display much and this of small importance. However, as far as their fibers are concerned, I cannot admire enough their delicate structure. Who studies any single fiber will see that in the middle part it is fleshy and at both extremities it is tendinous, a fact which is well known. But the composition of all the junctions appeared to me to be rather rare. Thus, the fleshy portion does not extend in a straight line from one extremity of the muscle to the other,

secuto ductu extenditur, sed inter latas tendinum expansiones fertur transversa, ita quidem ut carnosarum singulæ parallelum inter se obseruent situm. Si enim ab uno musculi extremito versus alterum fueret secundum fibrarum ductum sectio, hæc sc manifestam siset structuram.



A B Tendo per unam musculi superficiem se expandens.

C D Alter tendo per oppositam se superficiem diffundens.

E E Carnosa fibrarum portio inter utramque expansionem extensa.

Integri alias simplicisq; hæc est fabrica.



G H unius tendinis expansio.

I K expansio tendinis opposit.

L L carnosus venter.

z f

Sunt

but it traverses the muscle between the broad expansions in such a way that the single fleshy parts run parallel. When making a section from one extremity of the muscle to the other along the direction of the fibers, this structure is clearly seen.

A B The tendon extending over one surface of the muscle.

C D The other tendon extending over the opposite surface.

E F The fleshy part of the fibers between the two [tendon] extensions

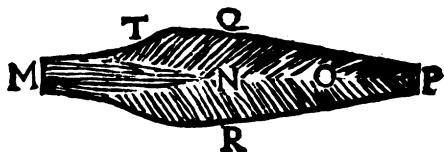
Otherwise the structure of a whole and simple muscle is as shown here.

G H One tendon extension.

I K The opposite tendon extension.

L L The flesh belly.

Sunt & musculi compositi, ieq; generis non  
unius; elegantissimi mihi vili, qvorum fibræ  
hōc modo dispositæ.



P. tendonum alter qvi in duas fundit expansiones, superior una versus Q diffunditur, altera inferior versus R se expandit.

M. alter tendo, qvi per medium ventrem suas dispergit fibras.

Ab N ad O & porro inter medium & duas exteriores oppositas expansiones parallelo du&tu feruntur carnosæ fibrarum partes.

Nec omittenda videtur qvæ cuilibet musculo peculiaris membrana, cuius fibrarum fitus transversus & inter carnosas fibras diffusio non parum ad motus explicationem conferre videatur. Sed de his, ut & de speciali qvorumdam notatu digniorum muscularum fabrica brevi plura, hæc enim tantum obiter Tibi volui significare, ut si qvid de illis à Te vel sectione observatuni, vel lectione, liceret Tua informatiōne gaudenti, tum laboris compendium facere,

There are also compound muscles, and not only of one kind. The ones which seem most elegant to me are those in which the fibers are disposed in the following manner.

P. One of the tendons which is split into two expansions, the upper one extends towards Q, the lower one extends toward R.

M. The other tendon which distributes its fibers through the middle of the belly.

From N to O and farther between the middle and the two opposite external expansions the parts of the fleshy fibers are parallel.

The membrane peculiar to every muscle must not be overlooked. The transverse orientation of its fibers and their distribution between the fleshy fibers seem to contribute not a little in the explanation of the movement. But about this and about the particular structure of some muscles more notice-worthy, more will be said later. For I wished to point out these matters to you incidently so that, if you observe something about them either by dissecting or by reading, it would be possible to the one delighted by your information on one hand to save work and costs and on the other hand,

cere, sumptuumq; tum descriptiois rationem secundum Tua dictata dirigere. Qvod substantiam Cordis spectat; evidenter, ut opinor, demonstratum dabo, nihil in corde reperiiri qvod non reperiatur in musculo, nec in corde considerari, qvod in musculo iavenitur, si illa respexeris, qvæ ad musculi faciunt essentiam, id qvod & de auriculis patebit verum. Erit & inde manifestum nullas in corde dari fibras vel rectas, vel circulares, vel, ut Vesalius describit, obliquas, sed unius omnes generis esse, simplices puta, qvales in qvolibet alio reperiuntur musculo, in eo tantum à reliquorum qvibusdam differentes, qvod non secundum rectam lineam extendantur sed ubi à basi conum versus obliqu; descenderint, iterum superiora versus dirigant cursum. Omnium autem, ut spero, fibrarum utramq; ex aut opia determinabo extremitatem, simulq; monticulorum seu lacertulorum usum, valvularumq; ortum, numerum, motumq;, & vasorum naturam spectantia non pauca. Videbunt hinc adversarii Tui, qvi figuræ in Anat. Tua reformat, (edit. Lugdun. an. 1651.) p. 245. expressas systolen cordis & diastolen nobis exhibentes existimarunt evidenti rationi è diametro repugnare, se ante victoriam cecinisse triumphantem,

to orientate the explanation of the description according to your precepts.

As far as the substance of the heart is concerned, I will, so I believe, make it obviously demonstrated that nothing is found in the heart which is not found in a muscle and nothing is absent in the heart which is found in a muscle, if you consider what makes the essence of a muscle. This will appear obvious for the auricles as well. Hence it is obvious that there are no straight or circular or, as described by *Vesalius*, oblique fibers in the heart. All are of the same kind. They are simple such as those which are found in any other muscle. In the heart, however, they are different from some of the others only in that they do not run straight but, where they go down obliquely from the base towards the apex, they return upwards. I will demonstrate at autopsy, I hope, both extremities of all the fibers, together with the function of the eminences or muscles, the origin of the valvules, their number and movement, and much of what concerns the vessels. Your opponents who reckon that the figures published in your *Anat. Reformat.* (edition of Leiden, 1651) on p. 245, showing us the systole and diastole of the heart are at the very opposite of obvious reasoning, will see from this that they have claimed a triumph before victory

phum, cum ex fibrarum structura resultans actio ibidem evidentissimè exprimatur. Sed fecellit illos de parenchymate cordis minus accurata opinio, qva illud se vesiculæ adinstar habere crediderunt, adeoq; cum brevius redditum intumescit, dilatari, cum longius concidit, angustius fieri. Qvod vero ibi & ligatura, & dissectione & tactu demonstras, idem & ipsa fibrarum evincit fabrica, unde etiam sere omnium qvæ ibidem p. 249. à Te de cordis in suis motibus forma exponuntur, ratio seddi potest. Sed & evidens erit conum non esse densissimum, sed ipsum ejus extremum, qvo loco fibrarum superiora versus fit intorsio, in corde bubulo aciculæ capite tenuus esse. Septum vero an pervium sit, necdum licuit videre. Cavernulas sequentes clausas offendit; quid qvod & exterioribus parietibus huc sint cavernulæ magnitudine reliquis non cedentes, sed & innumeris ille fibrarum per septum decursus idem videtur dissimilare.

Vix hæc, satis, ut vides, properanti exarata calamo, cum ecce mihi à Te litteras, quibus etiam paucis, antequam de Tabula manuam respondendum. Cavæ motum inspirationis respondentem à Domino van der Lahr credituram inventum, sed inde tribus illam debet inven-

since the action resulting from the structure of the fibers is described there most obviously. But the less accurate opinion on the parenchyma of the heart according to which people believed that the heart behaves like a bladder, thus that it dilates when it shortens and swells, and that it becomes narrower when it lengthens and collapses, misled them. The structure itself of the fibers proves what you demonstrate there with ligature, dissection and touching, and thus can explain almost everything which you present there on p. 249 about the shape of the heart during its movements. However, it will also be obvious that the conus is not the densest, but its apex, where the fibers return upwards, in the heart of an oxen, is thinner than the tip of a needle. It was not yet possible to see whether the septum affords a passage. Following the small cavities, I found them closed. The fact that also the external walls have their small cavities not smaller than the others as also that countless passage of fibers through the septum, seems to argue against it.

As you see, this is hardly sufficient for somebody who is quickening his writing as there is your letter to me to which I must answer, even if it is little, before I leave the table.

I had believed that the movement of the vena cava corresponding to inspiration was discovered by Mr *van der Lahr*, but after that I learned that this discovery was due to three gentlemen,

Inventionem didici, Fadburgio, van der Lahr,  
 & Beckero, qui simul sectiones rum temporis  
 institutae intererant. Quid compressionem  
 vicinarum partium in inspiratione depresso-  
 rum spectat, locum hic non poterit illa inven-  
 nire suspicio, cum & in collo & in abdomine  
 ab omnium aliis incumbentium vicinia libera-  
 ta vena nihilominus ita evacuetur, ut latera  
 ejus se tautuo contingant; nec quam pressioni  
 opponis, difficultas urgere videtur, cum non  
 requiratur ut tunicas venæ in thorace perva-  
 dat aëris; sed tantum ut in venis extra thoracem  
 existens sanguis, dilatatam intra thoracem ve-  
 nam ingrediatur. Pressioni verò ut faveam,  
 seqventia quasi cogere videntur. Extra omnem  
 namq; controversiam esse puto, aërem, cum  
 à pellente quocunq; vim patitur, vel densari,  
 eodem, in quo est, loco, vel alium in locum  
 propelli: ad condensandum autem magnam  
 requiri vim mechanica docet, & experientia  
 evincit condensationem nunquam succedere,  
 nisi pressum aërem ambientia corpora omnia  
 ad resistendum latis fuerint valida; quod si au-  
 tem vel minima pars ambientis resistendo fue-  
 rit impar, illico à trudente causa propulsus  
 aëris, qua elabatur, invenit rimam. Quid si  
 itaq; dum diductæ à se mutuo costæ, descen-  
 densq;

*Padbrugge, van der Lahr, and Becker*, who attended together the dissection organized at that time. For what concerns the compression of the depressed adjacent parts during inspiration, this idea cannot find any place here since, in the neck and in the abdomen, the vein freed of the vicinity of all the otherwise incumbent parts is nevertheless evacuated so that its sides touch each other. Nor does the objection which you advance against compression appear to be compelling, since it is not required for the air to spread through the membranes of the vein in the thorax. It is only required for the blood present in veins outside the thorax to enter the dilated vein inside the thorax. The following facts actually seem almost to compel me to favor compression. I think it is beyond any controversy that when air is acted upon by force from something which pushes it, it is either condensed by this compressing object in the place where it is, or it is propelled to another place. Mechanics, however, teaches that a great force is necessary to condense it and experience shows that condensation never occurs unless all the ambient bodies are strong enough to resist the compressed air. If even a small part of the surroundings is unable to resist, air propelled by a pushing cause finds there a cleft through which it escapes. Thus if, while the ribs moving away from each other

densq; diaphragma externo aëri vim inferunt, quantum exterior superficies aërem premit, tantum ei cedant quædam in thorace contentæ partes, necessarium existimare non densari aërem sed eo pelli, ubi minorem invenit resistentiam. Quæ autem cedunt, illa sunt, quæ thorace distento dilatantur, ut pulmones, & thoracem intra existens cavæ truncus; ut itaq; pulmones aër diductos implet, aut ipse potius non resistentes diducit, sic & extra thoracem existens sanguis cedentem cavæ intra thoracem tunicam ut distendat, eò tanquam versus locum sibi non resistentem propellitur. Quod si mea me hic sefellerit ratio, & à vero abduxerit, Tuis in viam reduci desiderarem rationibus. D. Hobokium suas Tibi in defensionem Blasii scriptas misisse litteras miror. Certè & sibi consuluisset & Blasio suo si impressionem dissolvisset; jam vero ut Blasius, sic & ille demonstrarunt illorum demum maximam esse temeritatem, quorum minima est experientia: nec credo in vastis sæpe voluminibus tot inveniendos errores, quot ibi in proprii inventi defensione commitit Blasius, suoq; Hobokius assensu confirmat. Miseret me Blasii, qui lingvam ante manumq; non potuit frenare, quam suis ipsis scriptis suam publico manifestam reddi-

and the diaphragm moving downwards exert a force on air, these parts contained in the thorax yield to air by as much as the external surface compresses air, I should judge necessary that air does not condense but that it pushes where it finds a smaller resistance. Those parts which yield are those which are dilated by the distension of the thorax such as the lungs and the trunk of the vena cava present inside the thorax. Thus air fills the distracted lungs or rather air displaces the parts which do not resist. The blood which is outside the thorax, to distend the yielding membrane of the vena cava inside the thorax is thus propelled to the place which does not resist it. If my reasoning misled me here and led me away from the truth, I should wish to be returned to the right path by your explanations.

I am amazed that Mr *Hoboken* sent you his letter to defend *Blaes*. He would certainly have deliberated with himself and with his *Blaes* if he had been opposed to the printing. As actually *Blaes* and himself demonstrate, those who have the least experience are the most presumptuous. I do not think that as many mistakes can be found in many big volumes as *Blaes* committed in the defence of what he found himself, errors which *Hoboken* endorsed by his approval. I pity *Blaes* who could not refrain from talking and then from writing. By his writings he publicly displayed

reddidisset indolem honesto homine parum convenientem. Qvod eqvos attinet muresq;, nec illorum inde crania , nec horum aperire licuit useros. Pro promissa Diatribe gratias ago maximas. Salutat Te Clariss Borrichius. Deusungius antiquum obtinet & Celeberr. Sylvio gravissima minatur; sed bruta hæc fulmina fvari risu ille Vir moderatissimus contemnit. Plura non licet addere. Vale & ama.

T.

Leidæ ult. April.  
Anno 1663.

discip.

Nicol. Stenonis.

EPIST. LXXI.

*De misericordia Corde.*

NICOLAO STENONIS

Leidain.

**A**Pologiz Tuz Prodromum rectè accepi, uti & missas magni vestri Sylvii disputationes uno volumini inclusas. Utriq; gratias ago. Tibi in primis, qvo parario & autore mittuntur. Doleo verò vicem tuam, qvod tot tantisq; circumdaris adversariis. Æmulatione hac honesta aluntur ingenia præclara. Optarem inter Te & Cl. Blasium amicitiae redintegratio-

a character which does not fit a respectable gentleman.

As far as horses and mice are concerned, it was not possible to open the skulls of the former nor uteri of the latter.

Thank you very much for the promised *Diatribē*. The famous *Borch* greets you. *Deusing*, as of old, threatens the famous *Sylvius* of the worst things. But this most moderate gentleman smiles contemptuously at these fulminations. I cannot add more. Fare well and love

your disciple

Leiden, 30 April 1663

N.S.

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The following letter, dated 25 July, 1663, is Thomas Bartholin's reply (E14).

(no. 71)